Promoting functional diversity

The Funcitree team in the field

Adapting agriculture

Set against a background of diminishing resources and climatic change, the **FUNCiTREE** project is designed to provide an ecological framework for sustainable and adaptable agro-forestry systems in Africa and Latin America

FUNCiTREE project coordinators, **Dr Graciela Rusch** and **Dr Fabrice DeClerck** outline the progress to date and the future possibilities for their functional diversity work in seasonally-dry eco-regions in Africa and Central America

INCREASING DEMAND FOR livestock products, climate uncertainty and resource degradation has, in recent years, been compounded by the rampant poverty of farmers in the semi-arid tropics, and consequently, they are calling for modernised agro-forestry systems (AFS) capable of providing multiple functions. These are trends tapped into by FUNCiTREE, a project which aims to develop regionally specific, trait-based and field tested AFS capable of providing critical agro-ecosystem functions in seasonally-dry Africa and Central America.

WHAT IS FUNCITREE?

The project's primary objective is to provide farmers with a portfolio of regionally suitable tree and shrub species. The concept is based on traits or attributes of species, in relation to the services

Can you explain the project?

GR: FUNCiTREE uses functional ecology, particularly the relationship between biodiversity and ecosystem functions, as its scientific framework. It establishes the linkages between the attributes, or traits of species and their capacity to provide specific functions.

What are the main differences between a managed ecosystem and AFS?

GR: AFSs are managed ecosystems where trees, crops, pastures and livestock interact. AFSs differ from savannas and dry forests in the amount and the structure of vegetation that covers the soil, faster decomposition of organic material in managed systems and sparsely dispersed habitats for species that depend on forests or trees.

Why did you select your areas of study?

GR: We selected the study areas because livelihoods in these systems are based on the use of trees, pastures and livestock. They have a pronounced climatic seasonality determined by prolonged droughts - the primary limiting factor to farmers, who traditionally have used different tree products to cope with limited fodder production during the dry season.

Could you outline the problems faced by farmers in the semi-arid regions of Africa and Central America? What are the flaws in their agro-forestry practices?

GR: The most severe problems are: i) seasonal and fluctuating rainfall, ii) overexploitation and iii) impoverishment and simplification of the natural resource base.

provided - as perceived both by the farmers and also in terms of fundamental ecological functions. FUNCiTREE hopes to make substantial contributions to AF and ecological science through its integration of theories and concepts from both fields, thereby providing a scientifically based model for the design of modernised AFS.

Project coordinator Dr Graciela Rusch believes that the project's success will stem from its unique methodology: "This trait-based approach - specifically designed to meet the specific management needs of the farmer, will permit the selection of species, or particular combinations of species, best suited to local conditions," she explains.

One of FUNCiTREE's key goals is the identification and characterisation of the main factors influencing the adoption/non adoption of AF in selected target areas. The project seeks to improve the performance of AFS in dry and marginal areas, with a particular focus on how species can be assembled according to their traits in order to improve the multi-functionality of AFS. The project will identify the potential of new multipurpose tree species suitable for AF in dry and marginal areas by grouping these species both according to their functional traits and their capacity to provide critical AFS services.

Another key aim is to enhance specifically the synergies between the varying species traits and to model how trait combinations contribute to the multi-functionality of AFS including soil, trees, crop/pasture and livestock. The team will evaluate the short and medium environmental impacts of AF and its socioeconomic implications through sophisticated interdisciplinary models, subsequently producing policy recommendations aimed at promoting AFS and related husbandry practices best adapted to specific local needs, while remaining universal in scope.

Essentially, FUNCiTREE hopes to improve the understanding of the socio-cultural, economic and ecological limitations to the adoption of good agro-forestry practices in livestock production systems in the seasonally-dry tropics, in order to expand and improve the practice of socioeconomically and ecologically sustainable livestock production in marginal areas.

THE FUNCITREE METHODOLOGY

FUNCiTREE will begin by assessing the commonalities and differences of socio-cultural and economical causes for adoption/non-adoption of AF practices in three seasonally-dry areas in Sub-Saharan Africa and Central America. Following this stage, it will establish ecological similarity between the species of the two sites, and whether farmers in Senegal, Mali and Nicaragua value the same traits as important.

FDC: One flaw in current AFS is the dependency on single species solutions, or silver bullets. FUNCiTREE argues that the native trees of these landscapes should be seen as a portfolio or toolbox where farmers can select the right species, or the right group of species for the right job.

Are there any particular species which have demonstrated a high level of compatibility, allowing them to be grown alongside other plants?

GR: FUNCiTREE is not centred on species, but rather on the species' attributes and in the complementary interaction between those traits. We are interested in attributes that are related to important ecological functions and also to the provision of services. We wish to understand which properties of the trees are chosen or could be chosen in the future by the farmers and how important ecological functions can be expected to change depending on the choice of trees with particular attributes.

Are there any particular tree or shrub species which have shown a significant capacity to provide critical AFS services in any region in both Africa and Central America?

FDC: The species pool in West Africa has many common species, but taxonomically they differ from species in Central America. What FUNCiTREE is most interested in however is the functional, rather than taxonomic,

How open have farmers been to the project's recommendations?

GR: FUNCiTREE is currently collecting data, so the project has not produced any recommendations so far. There are activities planned from next year to present the interview findings and eco-physiological data.

Who are your most influential partners?

GR: The FUNCiTREE consortium stems from a collaborative partnership between the Norwegian Institute for Nature Research (NINA) and the Centre for Tropical Agriculture Research and Eduction (CATIE), along with NINAs and CATIEs partners in Europe and Africa, including the Millennium Villages Project (Earth Institute at the University of Columbia).

What are the benefits of AFS for global water use?

GR: Water is vital in seasonally-dry climates, where it is profoundly affected by land use and plant cover. Drought tolerance in nature is not only a question of sustained productivity (or carbon sequestration) under a certain level of water limitation; it comprises a whole set of strategies enabling plants to persist when rainfall amounts fluctuate. The maintenance of a range of plant strategies will provide a wider resource base on which to sustain AFS production in systems that are water limited.

What is the project's future?

GR: Making increasing use of knowledge from biological and ecological science to understand the functioning of man managed systems and the effects of land use practices on fundamental bio-geo-cycles is crucial. Learning about how nature functions helps us understand how the resources that support human society work and consequently how to sustain ecosystem services.

FDC: Understanding the contribution of biodiversity to the provisioning of critical ecosystem services is essential in ensuring the long-term sustainability of society itself.

FDC: Dr Fabrice DeClerck
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GR: Dr Graciela Rusch
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FUNCiTREE

FUNCTIONAL DIVERSITY: AN ECOLOGICAL FRAMEWORK FOR SUSTAINABLE AND ADAPTABLE AGRO-FORESTRY SYSTEMS IN LANDSCAPES OF SEMI-ARID AND ARID ECO-REGIONS

OBJECTIVES

- To provide farmers in the regions with a portfolio of regionally suitable tree species which according to their attributes are capable of providing multiple services, as perceived by the farmers and in terms of fundamental ecological functions.

KEY COLLABORATORS

NINA, Stiftelsen norsk institutt for naturforskning, Norway

CATIE, Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica

WUR, Wageningen Universiteit, The Netherlands

CSIC, Consejo Superior de Investigaciones Científicas, Spain

CIRAD, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France

ISRA, Institut Sénégalais de Recherches Agricoles, Senegal

IER, Institut d'Economie Rurale, Mali

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DR FABRICE DECLERCK is a community and landscape ecologist born in Leuven Belgium. He holds degrees from Humboldt State University (BSc), Iowa State University (MSc), the University of California Davis (PhD), finishing with a Postdoc at Columbia University. His primary interest is in the application of ecological theory and concepts to improve the conservation value, sustainability, and productivity of agricultural landscapes in developing countries.

DR GRACIELA RUSCH is a plant ecologist born in Buenos Aires, Argentina. Her academic career started at the University of Buenos Aires with training in the areas of plant ecology and eco-physiology of managed ecosystems. She holds a PhD in Ecology from Uppsala University, Sweden.

constraints of trees and tree-understorey forage/crop production in seasonally-dry agro-forestry ecosystems and explore the framework of plant functional traits (PFT) in order to understand the role of agro-forestry multipurpose tree species in dry marginal areas.

Using the PFT framework, undervalued tree species will be identified with a view to creating a portfolio of PFT's that can be selected to specifically address production barriers. This will enable FUNCiTREE to propose a model to enhance synergies between the multifunction components of seasonally-dry livestock production agro-forestry systems. A final assessment will be made of the socio-economic framework of ecologically sustainable agro-forestry practices in the semi-arid tropics in order to establish the socio-economic implications of the adoption of the practice in the different case study areas.

PROBLEMS IN AGRO-FORESTRY

Agro-forestry is an ancient practice, which if properly designed can provide multiple, simultaneous ecosystem services including mitigation of green-house gases, maintenance of ecosystem health and biodiversity, food security, and poverty reduction. However, if poorly implemented, AFS can not only exacerbate existing problems, but also contribute to the overall negative effects of depleted ecosystems that have lost their capacity to provide critical functions.

Generally, agro-forestry practices worldwide have been successfully adopted in humid regions; however in semi-arid and arid regions in the developing world, agro-forestry faces significant challenges to achieve goals of ensuring food security, human and animal nutrition, fodder, shelter, energy, income and the long-term maintenance of ecosystem function.

The role of AFS is evolving. While the 1980s-90s emphasised agricultural productivity and improvement of livelihoods, the current concerns regarding global climate change, the rapid loss of biodiversity, and the continuing persistence of poverty in Africa, as well as parts of Latin America, mean that modern AFS must meet multiple goals, at multiple scales. To increase the adaptability of AFS, a portfolio of regionally available tree and shrub species whose functional, cultural, ecological, and production traits are known is critically needed.

In the past, farmers have been presented with a limited list of tree species, often exotic to the region, that are very good at providing a limited number of services (fodder, fuel, food or soil fertility). FUNCiTREE proposes that species should be understood by their attributes or traits, taking due consideration to traits related to drought tolerance and water use efficiency. Farmers should be able to review a portfolio of locally-available species, and to select species based on their capacities to perform functions.

A TRAIT-BASED APPROACH

Based on the World Agro-forestry Centre's TREE database and new assessments of the eco-physiological attributes of trees, FUNCiTREE proposes a trait and service based framework that will improve the development and design of modernised AFS for livestock farmers of seasonally-dry landscapes that are ecologically sound and adapted to local conditions. This approach will permit the identification of regionally available, but undervalued multipurpose tree species suitable for agro-forestry in dry and marginal areas. The project proposes a portfolio approach where tree species are classified functionally, based on their capacity to provide specific management needs, including drought tolerance and water use efficiency in dry conditions, competitive interactions with under-storey vegetation, and palatability and fodder value for livestock.

FUNCiTREE's research is unique in that it will combine ecophysiological traits such as a species water use efficiency, leaf litter quality, nitrogen fixing ability and drought tolerance, with culturally defined species traits such as Central American cattle farmers' distinction between 'good' and 'bad' canopy types for livestock and pasture productivity. This approach permits the enhanced understanding of synergies between the multifunction components of agro-forestry systems, including the relationship between ecological and cultural classifications of trees by traits.

THE SOUTH-NORTH-SOUTH COLLABORATION

Latin America and Sub-Saharan Africa have experienced distinct development trajectories, despite sharing similar environmental and production challenges. As solutions to agricultural and conservation problems have frequently originated from the temperate zones, by focusing on a South-North-South collaboration, the two regions' shared experiences can be used for the advancement of both.

This collaboration permits focus on shared barriers and solutions, as well as region-specific constraints. Rusch believes that this approach will illuminate plant functional traits, rather than specific species: "The difference in the species occurring in Africa and Central America is what will enable the comparison of tree attributes independently from the identity of the tree," she explains.

Traditionally, projects of this nature have linked developing countries with developed countries. FUNCiTREE proposes that beyond this traditional partnership, the capacity of Latin American and African farmers to share production practices and limitations, and contribute jointly to the establishment of sustainable solutions will greatly facilitate solutions specifically designed for seasonally dry regions, with increased innovation as an eventual goal.